



Wild American mink (*Neovison vison*) may pose a COVID-19 threat

Over the past year, farmed American mink (*Neovison vison*) have gained notoriety due to their unfortunate susceptibility to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes COVID-19 in humans. SARS-CoV-2-infected mink have been reported on fur farms across Europe and North America (OIE 2021), and whole-genome sequencing of the virus isolated from mink on farms in the Netherlands has provided evidence of both human-to-mink and mink-to-human transmission of the virus (Munnink *et al.* 2021). Further sequencing of samples from humans infected with mink-related SARS-CoV-2 in Denmark has revealed that the virus had accumulated mutations with potentially adverse consequences for human health (Larsen *et al.* 2021). In response, animal welfare organizations and others have called for the closure of mink farms on public-health grounds in Europe (FOUR PAWS in Europe 2020) and elsewhere (Xia *et al.* 2020).

But it's not just on farms that American mink pose a potential disease threat. Mink farms are porous, and feral populations exist in almost all countries where mink are currently farmed or have previously been farmed (Bouros *et al.* 2016). American mink are native to North America but now occur in the wild across most of Europe and Russia, and as far afield as Argentina (Figure 1).

Outside their natural range, American mink are invasive, and often have negative impacts on native taxa (eg Macdonald and Harrington 2003), including prey species and other predators that they outcompete and sometimes kill (eg the critically endangered European mink [*Mustela lutreola*]; Maran *et al.* 2016). Under the current global COVID-19 pandemic, the susceptibility of American mink to the virus (Molenaar *et al.* 2020; Oreshkova *et al.* 2020; Sharun *et al.* 2021), their widespread presence in

semi-aquatic habitats (Macdonald and Harrington 2003), and siting of fur farms in rural locations (Bouros *et al.* 2016) suggest that American mink may now pose a new threat to both humans and native wildlife. Although mink are a solitary species, which might minimize virus transmission and persistence (Delahay *et al.* 2021), the home ranges of individuals overlap (Macdonald *et al.* 2015) and like other mustelids they deposit feces at prominent marking spots that are investigated by neighbors (Hutchings and White 2000); such behaviors could facilitate viral transmission. In addition, during the mating season males will visit multiple females (Macdonald *et al.* 2015), and there is widespread and sometimes extensive movement of both males and females during the autumn when the young-of-the-year disperse from their natal territory (eg Oliver *et al.* 2016); both of these behaviors would also potentially facilitate viral spread if movements involve infected individuals. In Canada, there is evidence that the Aleutian Mink Disease virus – a parvovirus that causes spontaneous abortions in and mortality of mink and other mustelids – may be transmitted from farmed to feral mink (Nituch *et al.* 2011). Although human-to-human transmission of SARS-CoV-2 is currently the dominant mechanism for the spread of COVID-19, the establishment of a wildlife reservoir could undermine efforts to combat the virus, by providing a source for re-emergence at any time and promoting conditions for the emergence and potential spread of new variants (Delahay *et al.* 2021; Sharun *et al.* 2021). Amongst wildlife, a disease outbreak could be devastating for the last remaining European mink populations.

Reports of escaped SARS-CoV-2-infected mink in Oregon (ODA 2020) and an apparently wild mink in Utah that may or may not have been a fur farm escapee (OIE 2021) have already made the news. To date, known escapees have apparently been recaptured but there is no guarantee that future escapees will not evade capture, if they have not already. Countries without mink farms (eg the UK) are not without risk either,

given that feral mink could potentially be exposed to SARS-CoV-2 through sewage released into rivers (Franklin and Bevins 2020) intentionally or unintentionally (eg during flooding). Banning mink farming provides only a partial solution: it does not remove the risk of the establishment of a viral reservoir in wildlife.

In Europe, there are policies in place for the management of invasive species; for instance, under EU Regulation (1143/2014) on Invasive Alien Species (IAS), member states are obliged to implement “effective management measures” for species included on a list of Union Concern. In March 2018, a risk assessment proposing the addition of American mink to this list (Bouros *et al.* 2016) was submitted to the European Commission (EC). However, despite approval by the EC's Scientific Forum on IAS, mink were excluded from the EC's proposed list and from discussion in the voting process. Denmark led the opposition to the listing of mink in order to protect its fur farming industry, which, ironically, the pandemic has now destroyed (at least temporarily), as Danish fur farmers were compelled to slaughter millions of farmed mink in an attempt to contain the disease following reports of SARS-CoV-2-infected mink at more than 200 farms worldwide (WHO 2020). Mink farming has now been banned in Denmark until 2022.

Formal listing of American mink as a species of Union Concern would probably not have affected the fate of the Danish farmers or their mink in the current global pandemic; nevertheless, beyond the captive farmed environment, we argue that it is time to reconsider the place of invasive mink in the countryside. We urge vigilance and action in all European countries, and elsewhere, around mink farms. Testing for exposure to SARS-CoV-2 in wild American mink is required, which would, in countries where they have been introduced, be most efficiently achieved in combination with removal trapping. This approach would have considerable additional biodiversity benefits but only if carried out at a large scale, with coordinated action among neighboring countries. Europe has recorded some of the



Figure 1. Global distribution of wild American mink (*Neovison vison*), showing their native North American range and their introduced range, where they are considered an invasive species, in Eurasia and southern South America. Note that although American mink were eradicated from the Estonian island of Hiiumaa, they are present on the mainland; for further country-specific details, see CABI (2019). Image credits: CABI 2019 (map); © A Harrington (photo).

highest COVID-19-associated human mortality rates in the world; it would be a great pity if the EU failed to take the actions necessary to substantially reduce the risk of a virus reservoir becoming established in feral mink. For the benefit of conservation and human health, we believe that the landscape-scale management of invasive mink that many scientists have long advocated is warranted.

**Lauren A Harrington^{1*},
María Díez-León², Asunción Gómez³,
Andrew Harrington⁴,
David W Macdonald¹, Tiit Maran⁵,
Madis Põdra³, and Sugoto Roy⁶**

¹Wildlife Conservation Research Unit, University of Oxford, Oxford, UK (*lauren.harrington@zoo.ox.ac.uk); ²Royal Veterinary College, University of London, Hatfield, UK; ³TRAGSATEC, Madrid, Spain; ⁴Neovison Ecology Ltd, Eynsham, UK; ⁵Tallinn Zoo, Tallinn, Estonia; ⁶International Union for Conservation of Nature, Gland, Switzerland

Bouros G, Dekker J, Gómez A, *et al.* 2016. EU non-native species risk analysis – risk assessment for *Neovison vison*. Brussels, Belgium: European Commission.

CABI. 2019. *Neovison vison* (American mink). In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc/datasheet/74428#toDistributionMaps>. Accessed 18 Mar 2021.

Delahay RJ, de la Fuente J, Smith GC, *et al.* 2021. Assessing the risks of SARS-CoV-2 in wildlife. *One Health Outlook* 3: art7.

FOUR Paws in Europe. 2020. Joint open letter to the European Commission: eliminating potential COVID-19 reservoir on EU mink farms. Brussels, Belgium: FOUR PAWS in Europe.

Franklin AB and Bevins SN. 2020. Spillover of SARS-CoV-2 into novel wild hosts in North America: a conceptual model for perpetuation of the pathogen. *Sci Total Environ* 733: 139358.

Hutchings MR and White PCL. 2000. Mustelid scent-marking in managed ecosystems: implications for population management. *Mammal Rev* 30: 157–69.

Larsen HD, Fonager J, Lomholt FK, *et al.* 2021. Preliminary report of an outbreak of SARS-CoV-2 in mink and mink farmers associated with community spread, Denmark, June to November 2020. *Eurosurveillance* 26: 2100009.

Macdonald DW and Harrington LA. 2003. The American mink: the triumph and tragedy of adaptation out of context. *New Zeal J Zool* 30: 421–41.

Macdonald DW, Harrington LA, Yamaguchi N, *et al.* 2015. Biology, ecology and reproduction of American mink, *Neovison vison*, on lowland farmland. In: Macdonald DW and Feber RE (Eds). *Farming and wildlife: conflict in the countryside*. Oxford, UK: Oxford University Press.

Maran T, Skumatov D, Gómez A, *et al.* 2016. *Mustela lutreola*. Gland, Switzerland: International Union for Conservation of Nature.

Molenaar RJ, Vraman S, Hakze-van der Honing RW, *et al.* 2020. Clinical and pathological findings in SARS-CoV-2 disease outbreaks in farmed mink (*Neovison vison*). *Vet Pathol* 57: 653–57.

Munnink BBO, Sikkema RS, Nieuwenhuijse DE, *et al.* 2021. Transmission of SARS-CoV-2 on mink farms between humans and mink and back to humans. *Science* 371: 172–77.

Nituch LA, Bowman J, Beauclerc KB, and Schulte-Hostedde AI. 2011. Mink farms predict Aleutian disease exposure in wild American mink. *PLoS ONE* 6: e21693.

ODA (Oregon Department of Agriculture). 2020. Mink at affected Oregon farm negative for SARS-CoV-2, wildlife surveillance continues. Salem, OR: ODA.

OIE (World Organisation for Animal Health). 2021. COVID-19 portal: events in animals. Paris, France: OIE.

Oliver MK, Piernsey SB, Zalewski A, *et al.* 2016. The compensatory potential of increased immigration following intensive American mink population control is diluted by male-biased dispersal. *Biol Invasions* 18: 3047–61.

Oreshkova N, Molenaar RJ, Vreman S, *et al.* 2020. SARS-CoV-2 infection in farmed minks, the Netherlands, April and May 2020. *Eurosurveillance* 25: 2001005.

Sharun K, Tiwari R, Natesan S, and Dhama K. 2021. SARS-CoV-2 infection in farmed minks, associated zoonotic concerns, and importance of the One Health approach during the ongoing COVID-19 pandemic. *Vet Quart* 41: 50–60.

WHO (World Health Organization). 2020. SARS-CoV-2 mink-associated variant strain – Denmark. Geneva, Switzerland: WHO.

Xia C, Lam SS, and Sonne C. 2020. Ban unsustainable mink production. *Science* 370: 539.